The Applicant appreciates the Examiner's thorough examination of the subject application and respectfully requests reconsideration of the subject application based on the foregoing amendment and the following remarks.

35 U.S.C. 112, SECOND PARAGRAPH REJECTION

Examiner rejected claims 2-13 under 35 USC 112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter that the Applicant regards as his invention. More particularly, Examiner asserts that "the design operating speed" lacks an antecedent basis. Claim 2 has been amended. Accordingly, the ground for rejection is overcome.

35 U.S.C. § 102(b) REJECTION

The Examiner rejected claims 2, 3, 5-7, and 12 under 35 USC 102(b) as being anticipated by U.S. Patent Number 4,860,611 to Flanagan, et al. ("Flanagan" or the "Flanagan Reference"); claims 2, 4, and 6 under 35 USC 102(b) as being anticipated by U.S. Patent Number 5,816,114 to Gregoire, et al. ("Gregoire" or the "Gregoire Reference"); and claims 2-4, 6, and 7 under 35 USC 102(b) as being anticipated by U.S. Patent Number 5,628,232 to Bakholdin, et al. ("Bakholdin" or the "Bakholdin Reference"). The Applicant respectfully traverses these rejections for reasons detailed below.

According to the Flanagan Reference,

> The rotor behaves as a conventional metallic (solid) rotor at low speeds. As the speed of the rotor increases, a portion of the ring will lift off of the hub rim at the points where the spokes join the rim. At this point however the rotor has already achieved a substantial speed that is well above the critical frequency of the hub-ring components . . .

Flanagan, col. 2, lines 56-65. Moreover, Flanagan teaches a "fairly flexible system". Id., col. 2, line 53.

In contrast, the invention as claimed provides a "stiff metal hub that produces a critical speed substantially greater than the design operating speed of the flywheel." Application, page 5, lines 10-12 (Emphasis added); See also Id., page 7, lines 7-9. As disclosed in the Application:

> Flanagan et al. addresses the incompatibility problem . . . by keeping the critical velocity of the flywheel assembly 10 substantially lower than design operating speeds [so that] at low operating speeds where tight interference fit is maintained, there should be minimal separation of the composite rim 20 from the hub, and, therefore, no vibrations near critical velocity to cause resonance.

Id., page 7, line 30 to page 8, line 7 (Emphasis added). In short, Flanagan's flexible system teaches a hub with a relatively low critical velocity with respect to the design operating speed. Indeed, the Examiner freely admits that, "the flywheel achieves a speed above a critical velocity." Accordingly, the Applicant respectfully maintains that, Flanagan teaches away from and therefore cannot anticipate "a stiff, metallic hub . . . wherein the hub produces a critical velocity that exceeds a design operating speed of the flywheel assembly" as claimed by the present invention.

It is respectfully submitted that, for the foregoing reasons, independent claim 2 and all dependent claims thereof are not anticipated by the Flanagan reference and, further, satisfy the requirements of 35 U.S.C. 100, et seq., particularly § 102(b). As such, the Applicant believes that claims 2, 3, 5-7, and 12 are allowable. Moreover, it is respectfully submitted that the subject application is in condition for allowance. Early and favorable action is requested.

The Gregoire reference discloses a stiff hub portion 22 comprising two disk-shaped, i.e., shallow-dihedral (cone) shaped, hubs 22' and 22" that are spaced axially apart. See, e.g., Gregoire, col. 4, lines 22-26 and 58-62. In operation, the shallow

conical hubs 22' and 22" begin to flatten as the speed of the flywheel approaches operational speed. See, e.g., Id., col. 5, lines 33-38. Moreover, the hubs 22' and 22" are "completely flattened" at the upper end of the operational speeds. Id., col. 5., line 40.

In contrast, the hub of the present invention comprises a single, integral structure. Indeed, the hub of the present invention does not function, i.e., provide radial matching between the hub and the outer rim, by flattening out, which is to say, Gregoire relies on axial deflection to produce radial deflection. On the contrary, the web of the hub of the present inventions is and remains substantially planar when in use, which is to say, that the present invention relies strictly on radial deflection. The Applicant further asserts that with Gregoire the bending stresses at the curved bend juncture are prohibitively high to make the system work effectively. Accordingly, the Applicant respectfully maintains that, Gregoire does not teach and therefore cannot anticipate a one-piece, integral, metallic hub with a substantially planar web section, wherein the hub produces a critical velocity that exceeds a design operating speed of the flywheel assembly as claimed by the present invention.

It is respectfully submitted that, for the foregoing reasons, independent claim 2 and all dependent claims thereof are not anticipated by the Gregoire reference and, further, satisfy the requirements of 35 U.S.C. 100, et seq., particularly § 102(b). As such, the Applicant believes that claims 2, 4, and 6 are allowable. Moreover, it is respectfully submitted that the subject application is in condition for allowance. Early and favorable action is requested.

The Bakholdin reference teaches flywheel rotors with a conical hub 100 having a conical member 13 and an inner cylindrical member 15. More specifically, Bakholdin teaches rotor hub embodiments that include: a conical hub 100 having a slotted aluminum cylinder 17 to "bridge the space between the shaft 3 and the conical member 13"; Bakholdin, col. 4, lines 24-39; a multi-piece cylinder 17' that includes an aluminum cylinder 19 having a generally hexagon outer surface and a spring 20 that

is bonded to inwardly pointing teeth 21a; see, e.g., Id., col. 5, lines 52-61; and a multi-piece cylinder with a "smaller inner core 23 [that] is advantageously positioned radially inward of a conical member 13' [ ]." Id., col. 6, lines 52-60.

Bakholdin does not address rotor dynamics, i.e., critical speed/frequency. In a first example, i.e., a conical hub 100 having a slotted aluminum cylinder 17", Bakholdin asserts that the hub 100 "is satisfactory up to its limiting speed", Id., col. 5, lines 45-50. More specifically, it is "most suited to applications wherein the flywheel operates at low to moderate speeds" that do not exceed 1000 meters per second. Id., col. 2, lines 30-32 (Emphasis added). Such a low to moderate speed system clearly does not teach or anticipate the high speed system of the present invention. Moreover, according to Bakholdin, when "speeds in excess of 1000 meters per second are contemplated, a two-piece or three-piece composite cylinder advantageously can be used in place of the aluminum cylinder." Id., col. 2, lines 32-35. In contrast, the invention as claimed includes a web section that is integrally formed to a central core and an outer rim, i.e., a single, integral hub, that operates at high speeds, e.g., 22,500 rpm, which are well below the critical speed of the system. Accordingly, Bakholdin, which teaches a multiple-piece hub, cannot anticipate the invention as claimed.

It is respectfully submitted that, for the foregoing reasons, independent claim 2 and all dependent claims thereof are not anticipated by the Bakholdin reference and, further, satisfy the requirements of 35 U.S.C. 100, et seq., particularly § 102(b). As such, the Applicant believes that claims 2-4, 6, and 7 are allowable. Moreover, it is respectfully submitted that the subject application is in condition for allowance. Early and favorable action is requested.

With respect to all three references, the Examiner maintains that, "during start-up operation, a flywheel must accelerate from zero, therefore any flywheel inherently has a design operating speed below all of its critical velocities." In short, the Examiner is suggesting that the design operating speed of a flywheel can be zero and that "design operating speed" can be any speed at which the device operates. This

characterization of "design operating speed" is inconsistent with the term of art as it is used in the industry, with its use in the cited references, and with its use in connection with the invention as claimed. Indeed, the Examiner is confusing "start up" from an at rest condition and transition time with "design operating speed".

As a term of art, "design operating speed" is that speed or range of speeds for which the device is designed to operate under normal conditions. For example, in Examples 1 and 2 of Flanagan, design speeds of 21,900 rpm and 21,775 rpm, respectively, are provided. See, e.g., Flanagan, col. 4, line 55 and col. 5, line 8. Thus Flanagan does not suggest that the "design operating speed" is zero. In Gregoire, the specification describes conditions "[w]hen the flywheel 10 is at rest or at a speed below the selected design operating speed [ ]." Gregoire, col. 5, lines 46-48 (Emphasis added). Thus, Gregoire differentiates between a "design operating speed" and speeds below the same. Moreover, the design operating speed of a working embodiment of the invention as claimed is about 22,500 rpm, which is not zero. See, e.g., Application, page 8, lines 32-33.

Accordingly, the Applicant respectfully disagrees with the Examiner's mischaracterization of a start-up or transition speed as a "design operating speed".

35 U.S.C. § 103(a) REJECTION

The Examiner rejected claims 5, 8, 9, and 11 under 35 USC 103(a) as being unpatentable over Bakholdin; claims 8-10 under 35 USC 103(a) as being unpatentable over Gregoire; and claims 2-4 and 13 under 35 USC 103(a) as being unpatentable over U.S. Patent Number 5,634,381 to Thoolen ("Thoolen" or the "Thoolen Reference") in view of U.S. Patent Number 5,012,694 to McGrath ("McGrath" or the "McGrath Reference"). Applicant respectfully traverses these rejections for reasons detailed below.

As provided above, Bakholdin teaches a one-piece hub for low to moderate operating speeds and multiple-piece hubs for higher operating speeds. Because Bakholdin teaches away from a one-piece, integral hub at high operating speeds, it would not have been obvious for those of ordinary skill in the art to modify the dimensions of the hub to arrive at the present invention (claims 8, 9 and 11) or to design the system so that the critical velocity of the system is between about 1.4 and about 3 times the operating speed (claim 5).

Furthermore, Bakholdin does not address rotor dynamics at all. Thus, one skilled in the art would not have found in Bakholdin the necessary teachings to design a rotor hub that is compliant enough to deflect commensurate with the rim yet rigid enough to operate well below the design operating range. Bakholdin addresses deflection but does not teach, mention or suggest a hub that also is rigid enough to operate below critical speed.

Therefore, it is respectfully submitted that, for the foregoing reasons, independent claim 2 and all dependent claims thereof are not made obvious by the Bakholdin reference and, further, satisfy the requirements of 35 U.S.C. 100, et seq., particularly § 103(a). As such, the Applicant believes that claims 5, 8, 9, and 11 are allowable. Moreover, it is respectfully submitted that the subject application is in condition for allowance. Early and favorable action is requested.

As provided above, the Gregoire reference discloses a stiff hub portion 22 comprising two disk-shaped, i.e., shallow-dihedral (cone) shaped, hubs 22' and 22" that are spaced axially apart. See, e.g., Gregoire, col. 4, lines 22-26 and 58-62. Gregoire does not teach, mention or suggest a one-piece, substantially planar hub web, wherein the hub produces a critical velocity that exceeds a design operating speed of the flywheel assembly. Therefore, the dimensions of the hub at an operating speed of 22,500 RPM (claims 8-10) would not have been obvious.

Furthermore, Gregoire does not address rotor dynamics. Thus, one skilled in the art would not have found in Gregoire the necessary teachings to design a rotor hub that is compliant enough to deflect commensurate with the rim yet rigid enough to operate well below the design operating range. Gregoire addresses deflection but does not teach, mention or suggest a hub that also is rigid enough to operate below critical speed.

Therefore, it is respectfully submitted that, for the foregoing reasons, independent claim 2 and all dependent claims thereof are not made obvious by the Gregoire reference and, further, satisfy the requirements of 35 U.S.C. 100, et seq., particularly § 103(a). As such, the Applicant believes that claims 8-10 are allowable. Moreover, it is respectfully submitted that the subject application is in a condition for allowance. Early and favorable action is requested.

With respect to the rejections based on the Thoolen reference, Thoolen teaches a device that "can be used with a flywheel having a relatively large mass." Thoolen, col. 1, lines 39-41. However, Thoolen does not teach a rotor hub that is compliant enough to deflect commensurate with the rim yet rigid enough to operate well below the design operating range, which is taught by the present invention. Indeed, Thoolen reference does not teach a device that can be used for higher speeds, but rather a device for operating with heavier masses. As disclosed in the Application, "energy storage is proportional to the flywheel mass and the square of rotational velocity [ ]." Application, page 1, lines 18-19. Thoolen teaches a means to improve energy storage by upping the mass of the flywheel. The Thoolen reference is totally silent about the relationship between the critical speed and the design operating speed.

In contrast, the invention as claimed teaches a device to improve energy storage by increasing the rotational velocity. Accordingly, one skilled in the art attempting to improve flywheel energy storage would not have found the teachings of Thoolen helpful.

Moreover, Thoolen discloses a pair of flanges 6 disposed at an upper end and a lower end of a rotary axle 2, wherein the pair of flanges has an inner part 8 and an outer part 10 that are in communication with a rotary axle 2 and a rotor 4, respectively, and a connecting part 12 therebetween. See, e.g., Id., col. 2, lines 13-17. The connecting part 12 includes a first, outer, disc-shaped part 14 and a second, inner, disc-shaped part 16 that "are situated at a distance from one another in both an axial and radial direction." Id., col. 2, lines 23-27; FIG. 1. These disc-shaped parts 14 and 16 are connected to each other and to the inner and outer parts 8 and 10 via a plurality of intermediary parts via essentially right-angled transitions 20, 18 and 26.

In contrast, the present invention teaches a single, integral hub 40 with a single outer rim section 90 in tight interference fit with the composed fiber rim 20. See, e.g., FIG. 2 and 3. Furthermore, the web 20 of the hub 40 of the present invention is substantially planar. See, e.g., FIG. 4. Thus, there is nothing in Thoolen that teaches, mentions or suggests the invention as claimed.

With respect to claim 13, the Examiner asserts that Thoolen's figure number 20 is an axial stop. The Applicant respectfully disagrees with the characterization of the figure item number 20 as such. Indeed, according to the Thoolen reference, figure item number 20 is "an essentially right-angled transition" disposed between the outer part 10 and the first, outer, disc-shaped part 14. See, e.g., Thoolen, col. 2, lines 28-30. There is nothing to suggest that this transition performs as an axial stop.

It is respectfully submitted that, for the foregoing reasons, independent claim 2 and all dependent claims thereof are not made obvious by the Thoolen reference and, further, satisfy the requirements of 35 U.S.C. 100, et seq., particularly § 103(a). As such, the Applicant believes that claims 2-4, and 13 are allowable. Moreover, it is respectfully submitted that the subject application is in condition for allowance. Early and favorable action is requested.

According to the Examiner, McGrath teaches a stiff metallic hub comprised of steel or aluminum and, further, that it would have been obvious to combine Thoolen and McGrath to come up with the invention as claimed. However, the McGrath does not teach, mention or suggest the present invention or combining its teachings with those of Thoolen to come up with the present invention. Hence, McGrath does not make up for the deficiencies of the Thoolen reference.

Indeed, McGrath teaches a spring-metal expansion device 12, e.g., having a Z- or hat-shaped configuration, that can be disposed between at least two ring-like components 10a and 10b. See, e.g., McGrath, Abstract. As the flywheel rotates, "the support member 22 grows radially outwardly at a faster rate than the components 10a and 10b" to provide near zero stresses at the interfaces 16 and 18. Id., col. 2, lines 55-57; col. 3, lines 9-11. The McGrath reference does not teach, mention or suggest an integral hub having a central core, an outer rim section, and a continuous web section. McGrath further does not teach a rotor hub that is compliant enough to deflect commensurate with the rim yet rigid enough to operate well below the design operating range, which is taught by the present invention. Here again, the Applicant asserts that the bending stresses at the curved bend junctures are prohibitively high to make the system work effectively. Accordingly, the Examiner has not made a prima facie case of obviousness.

It is respectfully submitted that, for the foregoing reasons, claims 2-5, 8-11, and 13 are not made obvious by the references and, further, satisfy the requirements of 35 U.S.C. 100, et seq., particularly § 103(a). As such, Applicant believes that the claims are allowable. Moreover, it is respectfully submitted that the subject application is in a condition for allowance. Early and favorable action is requested.

The Applicant believes that no additional fee is required for consideration of the within Response. However, if for any reason the fee paid is inadequate or credit is owed for any excess fee paid, you are hereby authorized and requested to charge Deposit Account No. **04-1105**.

Respectfully submitted,

Date: July 24, 2002

By: _____
George W. Hartnell, III
Reg. No. 42,639
Attorney for Applicant(s)

Dike, Bronstein, Roberts & Cushman
Intellectual Property Practice Group
EDWARDS & ANGELL, LLP
P.O. Box 9169
Boston, Massachusetts 02209
(617) 517-5523
Customer No. 21874
306398

MARKED-UP VERSION OF AMENDED CLAIMS

Amend the following claim to read:

2. (Thrice Amended) A stiff, metallic hub for an energy storage device, having a flywheel assembly, wherein the hub produces a critical velocity that exceeds ~~the~~ a design operating speed of the flywheel assembly, the stiff, metallic hub comprising:

a central core in tight interference fit with a rotary shaft of the flywheel assembly;

an outer rim section in tight interference fit with a high-strength, low-density composite fiber rim of the flywheel assembly; and

a substantially planar web section,

wherein the web section is integrally formed to the central core and the outer rim section.